RANGE-ONLY RADAR

During an electronic countermeasures (ECM) environment, the range data on a target are most affected. For that reason, the Hawk system has a range-only radar (ROR) that is used when required as an auxiliary means of providing range information for the system. The ROR (fig 74) is a pulse-type, quick-response, range-measuring radar that operates in a separate frequency band from the other radars in the system. It is normally operated remotely from the BCC. The ROR can be activated manually by the fire control operator or automatically by one of the illuminator radars. Once activated, it is slaved to the associated illuminator in azimuth and elevation and presents a video signal to the BCC where formulation of range data are accomplished.

LAUNCHER

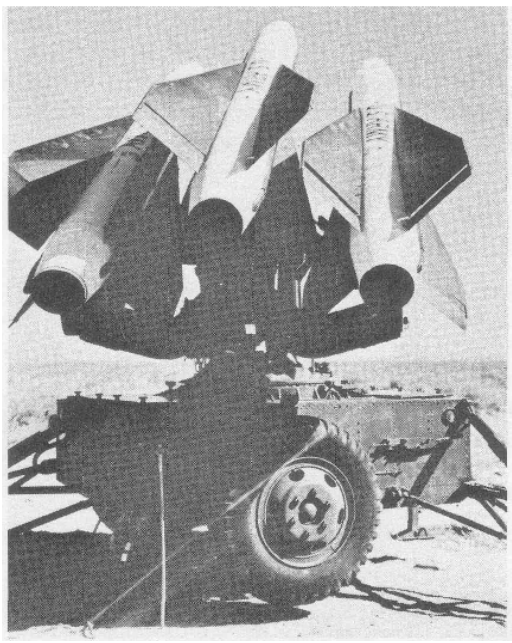


Figure 75. Hawk launcher and missiles.

During the Hawk firing sequence, the launcher (fig 75) receives tactical commands from the BCC and positioning commands from its associated illuminator. When the illuminator is locked on the target, a selected launcher slews to the same azimuth and elevation as the illuminator antenna. As the radar tracks the target, the antenna position changes constantly. The three-place launcher automatically aims the missiles in azimuth and elevation to agree with the antenna position information received from the illuminator. Approximately 3 seconds after a fire command is transmitted from the BCC, the missile is launched. The 3-second delay enables stabilization of the missile tracking antenna and permits the launcher to select a missile, activate the missile power supplies, and slew to the lead angle commanded by the illuminator. If the missile selected by the launcher firing selector does not leave the launcher, the HANGFIRE lamp in the BCC will light and the next ready missile is automatically selected.

HAWK MISSILE

The Hawk missile (fig 76) is propelled by a two-phase thrust, solid-propellant motor and uses semiactive homing guidance. It is 16 feet, 6 inches long; 14 inches in diameter; weighs approximately 1, 295 pounds; and has a dart-cruciform configuration. It has three basic functional systems: propulsion, guidance, and warhead. The missile body is divided structurally into two parts. The front body section consists of the radome, target tracking antenna with a hydraulic assembly which positions the antenna, hydraulic accumulator, electronic guidance and control chassis, and electrical power unit. The rear section consists of the warhead section, rocket-motor section, eleven actuator section, and four wing assemblies.

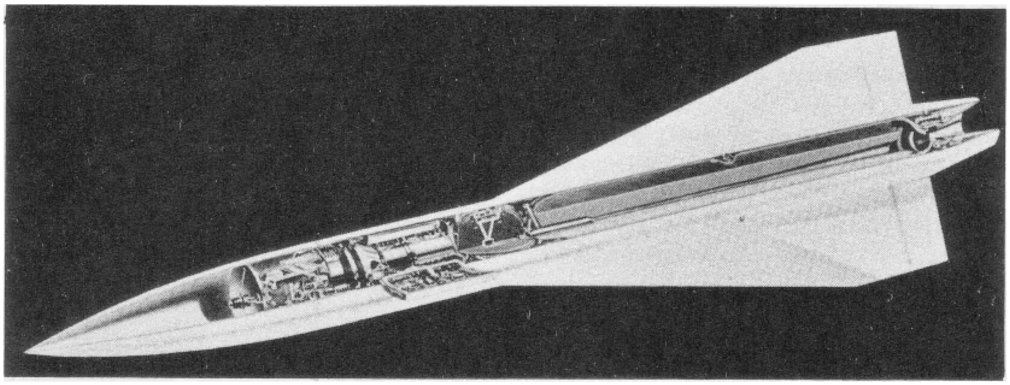


Figure 76. Hawk missile.

Initial thrust to boost the missile to operational speed and sustaining thrust to maintain that speed are provided by the propulsion system. The guidance system uses energy reflected from the target to continually compute a collision course. The warhead system explodes the missile warhead at the optimum point to insure target kill. For safety purposes, a destruction system is provided to destroy the missile in flight if required.

PALLET

Hawk guided missile pallets are used for storing and transporting ready missiles. The pallet, which may be mounted on a 2-ton, two-wheel trailer (fig 77), consists of three missile support arms and two index fittings connected to the skid. The missile support arms are contoured to the shape of the missile, each arm having a forward and rear missile latch to secure a missile. The index fittings are provided to position the loader properly for the transfer of missiles to or from the pallet. A pallet with three missiles can be transported by helicopter when the trailer is detached.

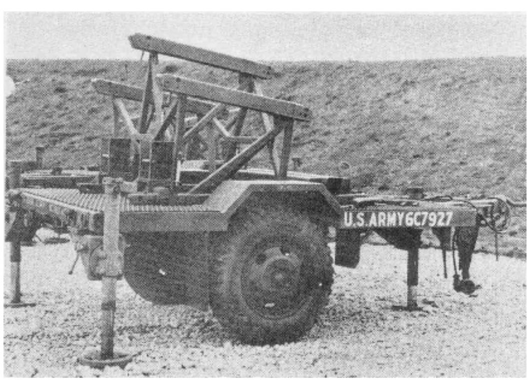


Figure 77. Hawk pallet mounted on 2-ton trailer.

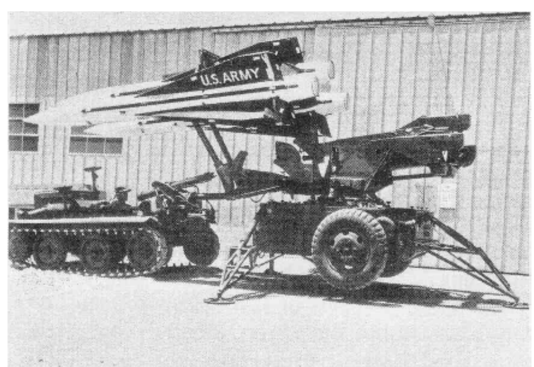


Figure 78. Loader-transporter transferring missiles to launcher.

LOADER-TRANSPORTER

The lightweight loader-transporter is a full-track, self-propelled vehicle used to transfer from one to three missiles between the pallet and launcher (fig 78). When rigged as a crane, a secondary function of the loader-transporter is to pick up and transfer individual missiles and missile components. During movement of the battery, the three loader-transporters (organic to the battery) are carried in the cargo beds of extra-long-wheelbase 2l-ton trucks.

ASSAULT FIRE UNIT

For special operations, such as helicopterborne (fig 79) and amphibious assaults (fig 80), a portion of the Hawk missile battery can be detached and used as an assault fire unit (AFU). This enables the battery to move by echelon and still remain operational during the move.

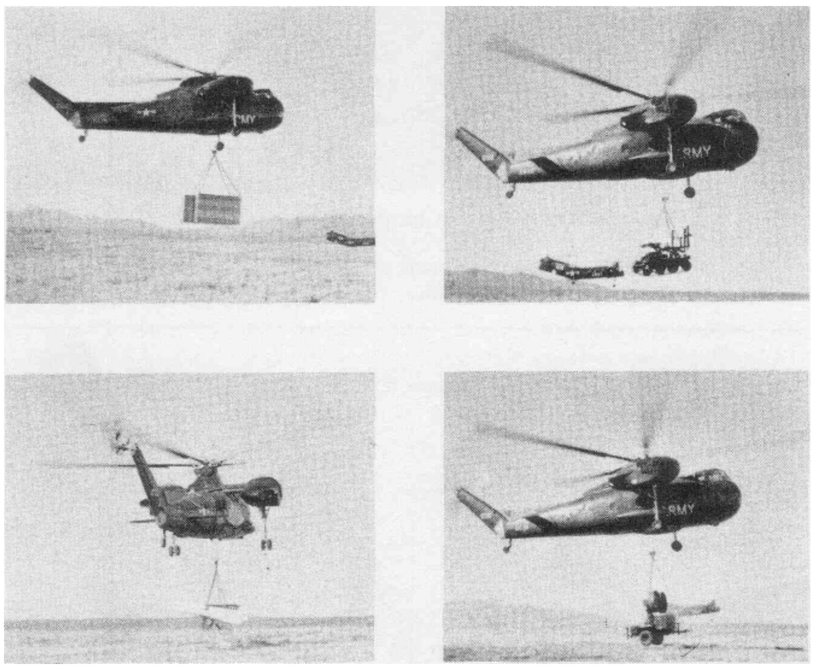


Figure 79. Hawk unit in helicopterborne operation.

The assault fire command console (AFCC) (fig 81) is the fire control central for the AFU and is capable of remote control of the AFU or the augmented assault fire unit (AAFU). The AFU consists of one AFCC, one illuminator, one launcher, one pallet with three missiles, one loader-transporter, one crew chief junction box, and the necessary power equipment. The AFU may be augmented by the addition of one CWAR and up to two more launchers with additional pallets and missiles. Equipment may be added until the complete Hawk battery is emplaced. When the full battery is emplaced, control of the unit is changed from the AFCC to the BCC. Indicators are provided on the AFCC (fig 82) for display of equipment status and other information necessary for tactical control of the AFU or AAFU.

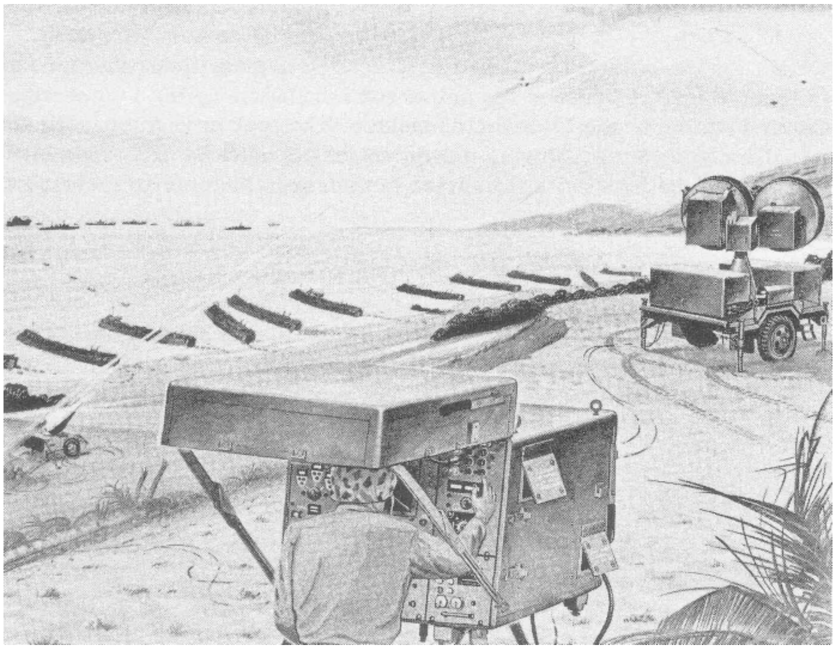


Figure 80. Hawk in amphibious assault.

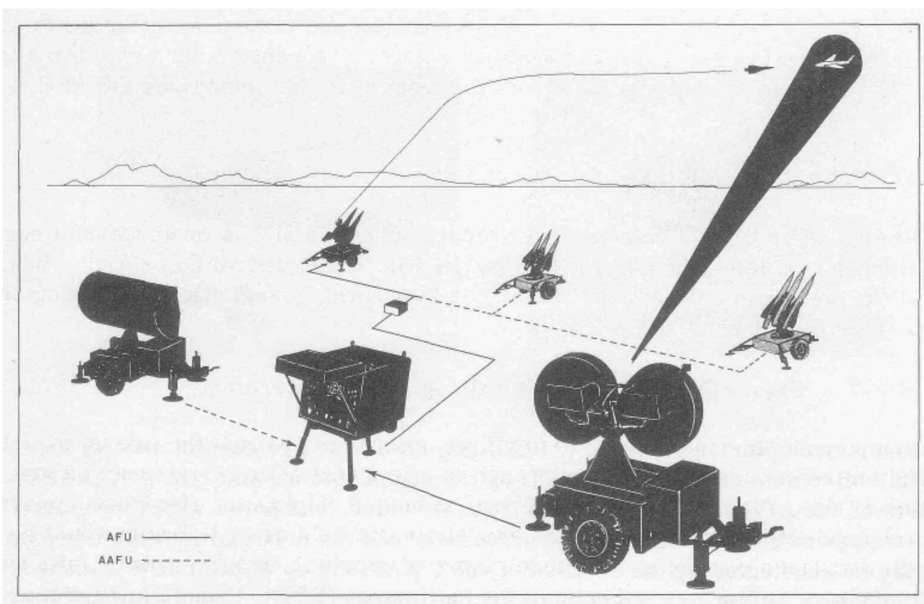


Figure 81. Scheme of operation, AFU and AAFU.

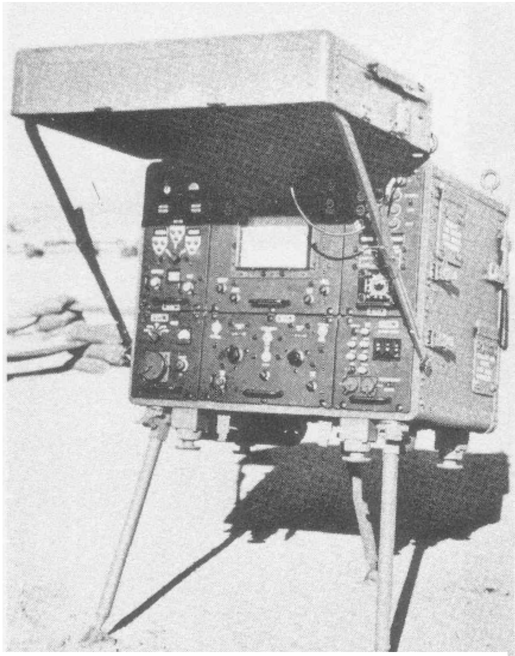


Figure 82. Assault fire command console.

When the AFU is used, the illuminator operates in a predetermined search pattern for a given sector, as determined by the tactical situation. As a target enters the radar search pattern, the illuminator will automatically lock on and track it. After lock has occurred, the operator evaluates the indications presented and insures that the desired target is being tracked. The launcher is slaved to the azimuth and elevation of the illuminator, thereby aiming its missiles directly at the target. When the target is within range, the AFCC operator electronically issues a missile fire order. The sequence of events after the fire order is initiated is identical to the sequence when using the BCC.

When the AAFU is used, targets are primarily detected by the CWAR and displayed on a radar screen at the AFCC. Additional search capability can be obtained by causing the illuminator to search in a predetermined pattern. When a target is detected, the AFCC operator will remotely position the illuminator to the azimuth of the target and the radar will search for and lock on the target. After lock indications are received, the operator insures that the correct target is being tracked and then selects a launcher from which missiles will be fired. The subsequent sequence of events is identical to that used when the AFU is employed.

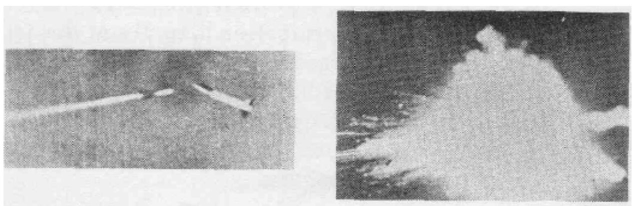
HAWK ANTIMISSILE CAPABILITY

The Hawk system has demonstrated its accuracy and reliability by successful engagements against Honest John (fig 83), Little John (fig 84), and Corporal (fig 85) missiles. Addition of the high-power illuminator radar has increased system effectiveness against targets having small radar cross sections.

EMPLOYMENT

The primary employment guideline for Hawk units is to position the fire units well forward along the low-altitude routes of approach to effect enemy target destruction prior to release of weapons, regardless of the delivery technique employed. Hawk units providing AD for vital area defense and priority targets within the field army likewise would be located well forward along the low-altitude routes of approach into the area. Units should be placed no closer to the forward edge of the battle area (FEBA) than 10 kilometers.

Figure 83. Hawk destroys Honest John.



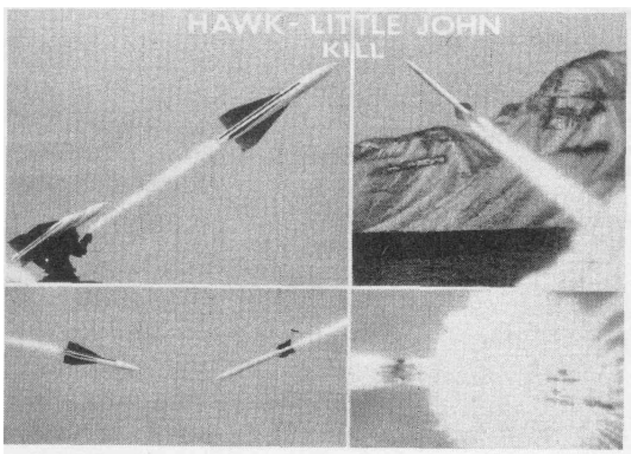


Figure 84. Hawk destroys Little John.

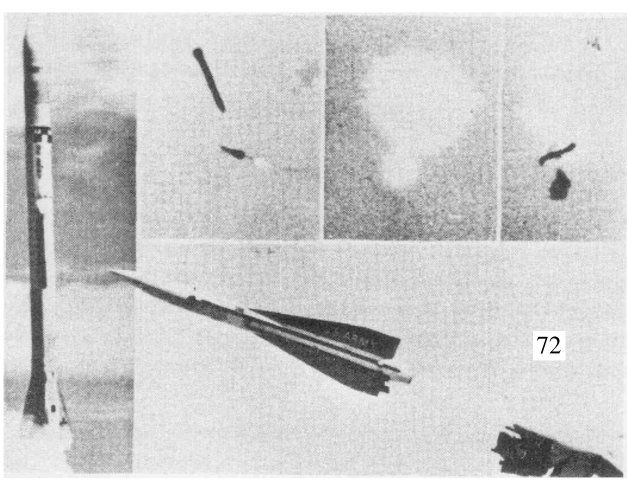


Figure 85. Hawk destroys Corporal.

GUIDED MISSILE SYSTEM RADAR SIMULATOR STATION (AN/TPQ-21)

Until the recent development of the AN/TPQ-21, the Hawk unit commander had insufficient means at his disposal for adequate realistic training of on-site radar operators. To train Hawk battery control central (BCC) operators, it was necessary to obtain high-performance aircraft equipped with electronic countermeasure emitters. In CONUS, the cost and availability of aircraft and the Federal Aviation Agency's control of flight patterns and the use of electromagnetic emanations all contributed to a reduction of training effectiveness. In oversea forward areas, tactical aircraft have difficulty in simulating hostile actions and emitting ECM without providing the enemy with information of an intelligence nature. This situation has been improved considerably by use of the AN/TPQ-21 (fig 86), which will be issued to Hawk units in the near future.

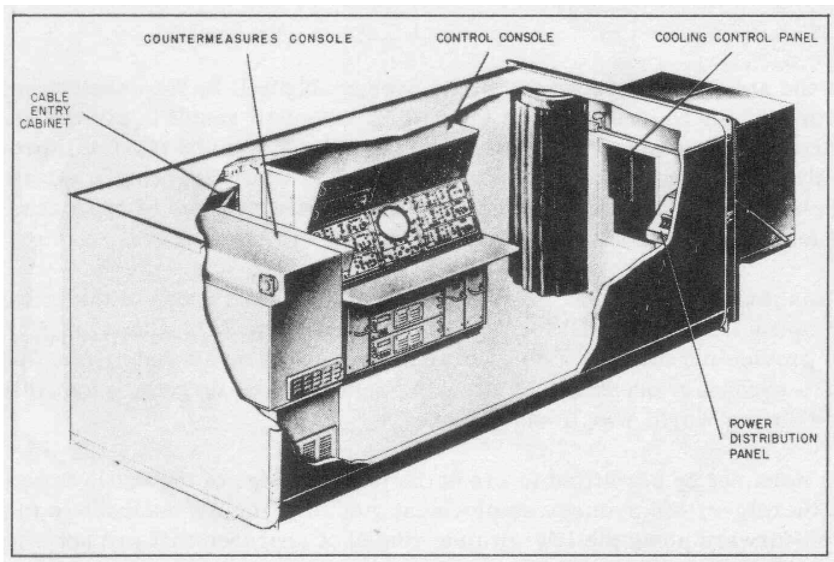


Figure 86. AN/TPQ-21 (cutaway view).

When connected to the Hawk system, this simulator provides an artificial tactical environment for the training of operators. No change in operation of the BCC is apparent to the operators when using the AN/TPQ-21 for target engagement. With the technique of inserting video, doppler, and other simulated effects, the ECCM features of the Hawk radars are used and the operator can be evaluated as to his ability to counter ECM.

The AN/TPQ-21 is inclosed in a Craig shelter similar to the battery control central and has the same transportability feature (helicopter, cargo aircraft, or truck). It is capable of simulating six airborne targets, each independently maneuverable against the Hawk battery. Simulated targets can emit ECM if so programed. Targets may be designated as hostile or friendly, and the size can be varied to produce returns of any desired cross section from 1 to 25 square meters.

The simulator also can produce complete launcher effects, AADCP symbology, radar ground clutter, IFF, and simulated responses from the five radars of the Hawk battery.

A quick-disconnect feature permits the simulator to be electrically switched in or out of the Hawk functional system in a few seconds, thus the change from a training status to combat readiness can be done immediately.

AIR DEFENSE ARTILLERY AUTOMATIC WEAPONS EMPLOYMENT

Since the end of hostilities in Korea, tactical doctrines have been revised and refined in the light of combat experiences and the improved capabilities of the materiel available for air defense. Also, the reorganization of the Army divisions imposed new requirements on AAD units. This reorganization has increased the problem of providing a workable AD for widely dispersed forward elements of the field army. These divisions require strong and effective AD if they are to live and fight from day to day. ADA, now more than ever, must provide the active air defense of units in the forward areas to afford protection against air attack.

Much of the air defense of forward areas presumably will be furnished by missile systems; however, it may be expected that terrain features will result in air corridors below the radar horizon. This lack of AD radar coverage of the division front will provide the enemy with airspace in which to achieve surprise and in which aggressive air attacks may persist. These air corridors will be virtually uncontested avenues of approach, not only endangering forward area units, but AD and other support units as well.

To fill this missile gap at low altitudes and in the forward areas of the battlefield, AD automatic weapons (AW) units will form a definite part of the AD. Gun-type ADA weapons will not only provide the division a defense against attack aircraft and airmobile forces but also possess a secondary capability of attacking point surface targets, a capability well demonstrated during World War II and in Korea.

Aircraft must not be permitted to cross the forward edge of the battle area (FEBA) unobserved; therefore, the primary employment guideline for AW weapons is to position the fire units well forward along the low-altitude routes of approach that are not effectively covered by other AD systems.

The Army is currently testing other gun systems with improved capabilities to replace or to complement the M42. These advanced guns are rapid firing, multiple-barrel systems that are highly accurate and possess a high degree of mobility.

TWIN 40-MM GUN M42

The self-propelled, full-tracked, twin 40-mm gun M42 is an armored AD weapon. This vehicle (fig 87) was designed for employment with divisions for air defense; but because of its rapid rate of fire, it has also proved a valuable support weapon against ground targets. It has a cruising range of 100 miles at speeds up to 45 miles per hour, a fording depth of 40 inches, and a weight of 24 tons.

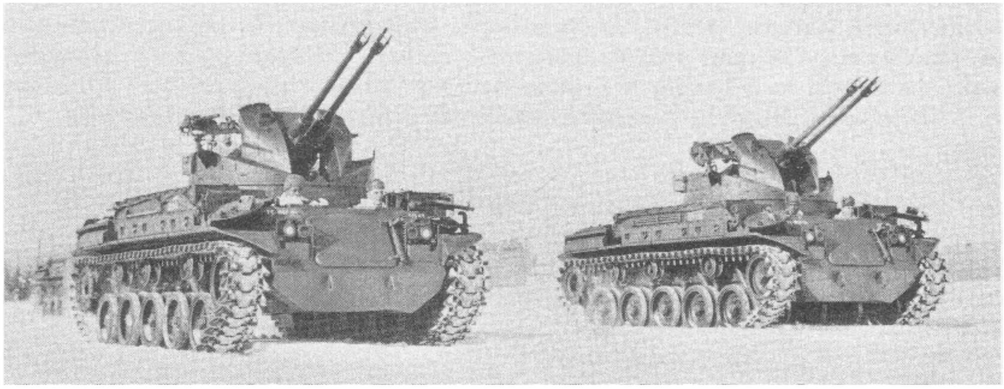


Figure 87. Twin 40-mm guns M42.

Major armament is the dual 40-mm automatic gun M2A1 mounted on the 40-mm gun mount M4E1. The 40-mm gun is a high-velocity, flat-trajectory, clip-fed, automatic-loading weapon capable of firing 240 rounds per minute. The cyclic functioning of each gun is automatic from the firing of one round to the next.

The welded armorplate gun mount is an open-topped cylinder in the center section of the vehicle. This mount is supported on a ball bearing race ring and can be traversed 360° in either direction by power (9 seconds) or manually (10.3° per crank revolution). Crew positions for the squad leader, gunner, and two cannoneers are in the gun mount.

Three sighting devices are incorporated into the fire control system: the computing sight M38, reflex sight M24C, and speed ring sight.

The computing sight M38 is designed to provide an effective means of controlling fire of the 40-mm gun against either a vehicular or aerial target.

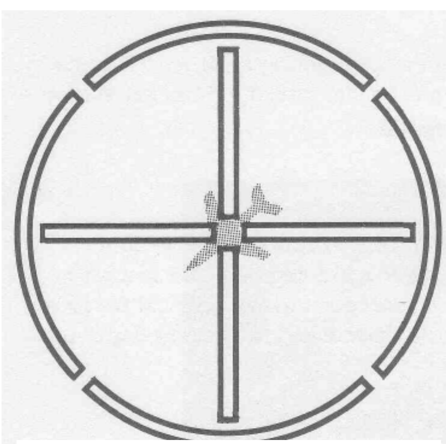


Figure 88. Reticle pattern, reflex sight M24C.

The reflex sight M24C is designed to superimpose a reticle pattern in the gunner's line of sight (fig 88) and is used in conjunction with the M38 computing sight during power operations .

The speed ring sight is used during manual operation if a power failure or local control system malfunction occurs. It has a rear peep element and a series of concentric circles as a front element.

The communications system of the M42 gun consists of radio set AN/VRC-9, radio receiving set AN/GRR-5, an intercommunications set, and interphones. This equipment is shock-mounted on support shelves in the driving compartment. The AN/VRC-9 is used for intervehicular and command communication, and the AN/GRR-5 provides AD intelligence.

The M13 periscope is used by the driver and commander while operating under combat conditions during daylight, and the M19 periscope, a binocular-type, enlarged view device, is used when driving the vehicle under blackout conditions. Infrared rays are projected forward from the blackout headlights to illuminate the field of view. The M19 periscope converts the infrared image to a visible image which is viewed through conventional eyepieces.

ANTIAIR WARFARE WEAPONS OF THE U.S. NAVY

In fulfilling its antiair mission, the U.S. Navy employs missiles in both the surface-to-air and air-to-air roles. Some of the weapons available to NORAD for defense of the North American Continent are discussed below.

AIR-TO-AIR MISSILES

Sidewinder, which uses infrared passive homing (he at-seeking) guidance, was developed by the Navy and is designed for use in attacks against jet aircraft. It is also used by the Air Force and Marines. Against a mach 2 target at 60, 000 feet altitude, the missile has a range of approximately 4 miles. This solid-propellant missile is the first air-to-air missile to have destroyed aircraft under actual combat conditions. It was successfully employed by Chinese Nationalists in the defense of Quemoy in 1958. The Sidewinder (fig 89) is more than 9 feet long, weighs more than 155 pounds, and delivers a high-explosive warhead. Sidewinders are carried (fig 90) as armament in the F4D, F3D, F8, MF1C, F1C, and F11F aircraft.

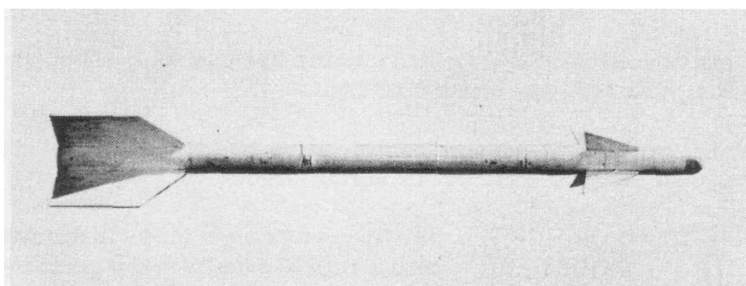


Figure 89. Sidewinder missile.

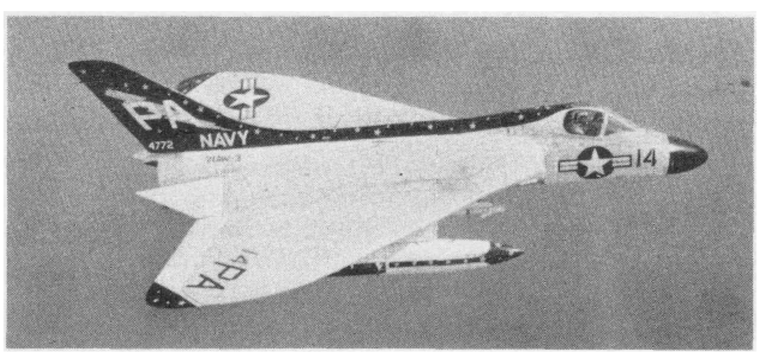


Figure 90. Navy Skyray *(t'lLJ)* ali-weauier lighter with bicie winder.

Sparrow III is the latest in this series of missiles. Its electronic homing guidance system permits attack of high-performance aircraft from all aspects, including head-on. An all-weather missile, its low-altitude capability, accuracy, and kill probability are excellent. Sparrow III is about 12 feet long and weighs about 400 pounds. This solid propellant missile, shown in figure 91 as it is fired from a Navy F3 Demon aircraft, attains a speed of 1, 500 miles per hour, has a ceiling of 60, 000 feet, and employs a high-explosive warhead. Sparrow is carried aboard the Navy's all-weather fighters, the F3B Demon and F43 Phantom II.

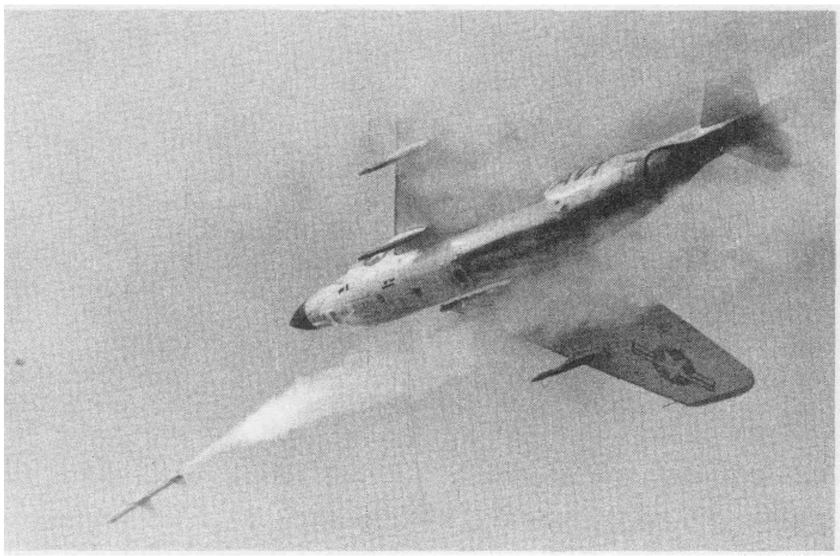


Figure 91. Sparrow III fired from Demon aircraft.

SURFACE-TO-AIR MISSILES

Terrier (fig 92) has been operational with the U.S. Fleet since 1956. It uses beam-rider guidance, is 13 inches in diameter, is about 27 feet long, and, with booster, weighs about 3, 000 pounds. It has a range of 20 miles up to an altitude of 80, 000 feet and carries a high-explosive or nuclear warhead. This missile is fired in a sequence that is automatic from selection of the ready round in the magazine through launching; only seconds are required for the entire sequence. These missiles are currently operational on cruisers, destroyers, and a few carriers.

Talos, a surface-to-air, beam-riding missile (fig 93), uses a solid fuel rocket motor for boost and a ramjet engine sustainer to attain a range of 100 miles. Talos is 30 inches in diameter, 32 feet in length, and weighs 3, 000 pounds (more than 7, 000 pounds including booster). First fired at sea in 1959, the missile delivers a high-explosive or nuclear warhead at supersonic speed up to 80, 000 feet altitude.

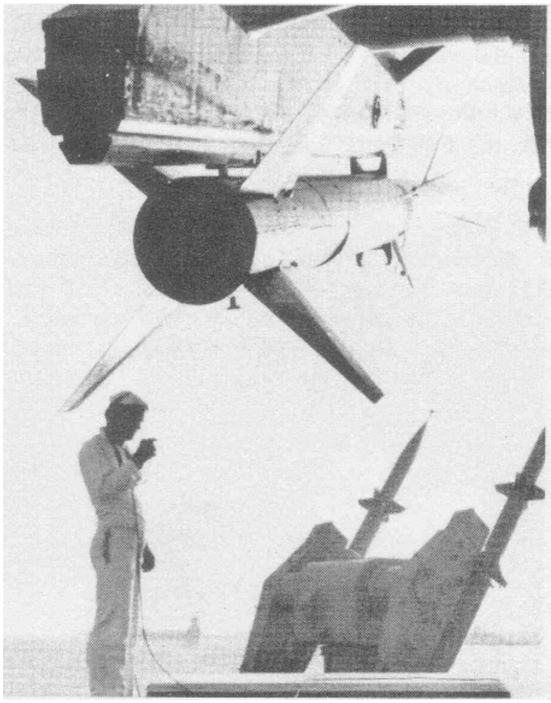


Figure 92. Terrier missile batteries on U.S.S. Boston.

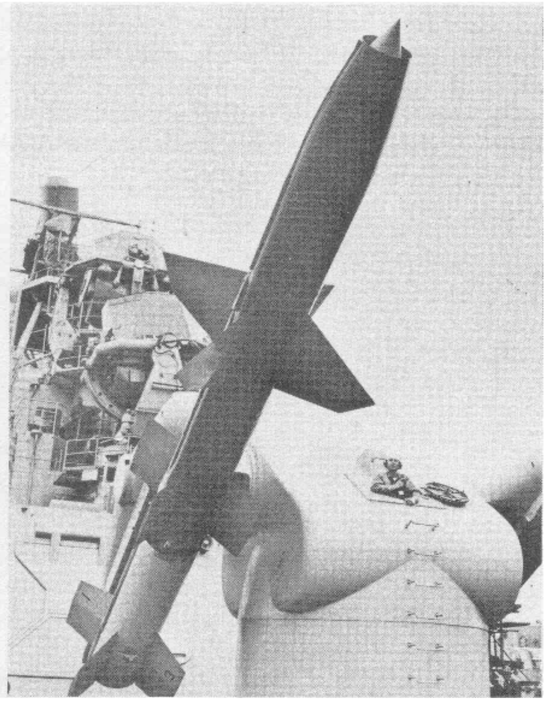


Figure 93. Talos missile battery on guided missile cruiser, U.S.S. Galveston.

Tartar (fig 94) is designed for use on destroyer-type ships of the fleet. It is effective against both low- and high-altitude targets and carries a high-explosive warhead to a range of 17 miles and up to 65, 000 feet altitude. A dual-thrust, solid-propellant rocket accelerates the missile to supersonic velocity. Its overall length is about 12 feet and its diameter is slightly more than 1 foot. Tartar is used as a secondary battery aboard Talos-equipped cruisers.

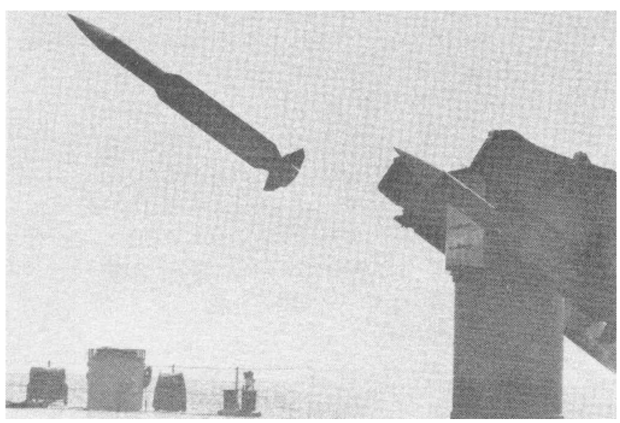


Figure 94. Tartar missile fired from U.S.S. Norton Sound.

AIR DEFENSE COMMAND INTERCEPTORS

The USAF Air Defense Command employs four types of all-weather interceptor aircraft plus a variety of air-to-air missiles to accomplish its mission and act as a deterrent AD force.

The F-101B Voodoo (fig 95) can be employed in fighter and reconnaissance roles as well as an interceptor. Produced in five models, the two-place F-101B is used as an interceptor, while the other models are used as both interceptor and reconnaissance aircraft. The F-101B can develop a speed of mach 1.8 at 40, 000 feet with a ceiling of more than 50, 000 feet and a range of over 1, 200 miles. This interceptor is armed with a combination of Genie air-to-air rockets and Falcon air-to-air missiles.

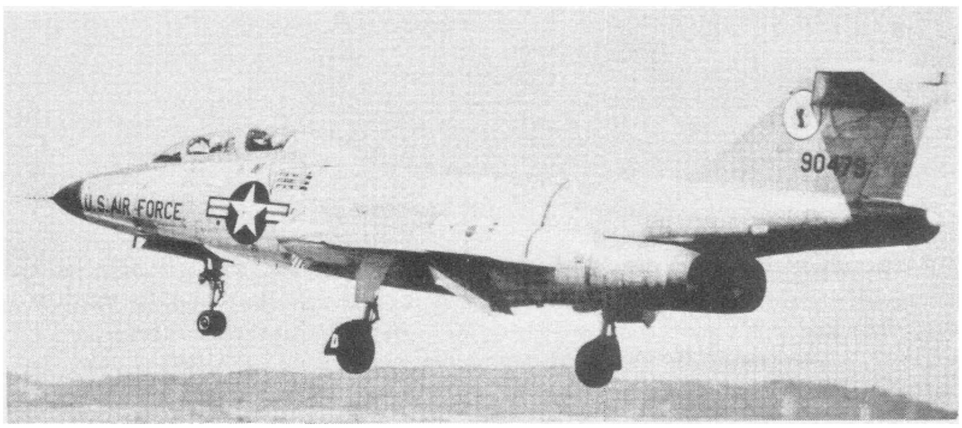


Figure 95. F-101B Voodoo.

The F-102 Delta Dagger (fig 96) was the world's first supersonic all-weather jet interceptor and the first to incorporate the area rule (coke bottle) fuselage design. Using all electronic equipment, the radar locks on the target and, at the right instant, the electronic fire control system automatically prepares and fires its weapon. Operational data show a supersonic speed with a ceiling of more than 50, 000 feet and a range of more than 1, 000 miles. Main armament is a combination of AIM-26 and AIM-4 Falcon missiles.

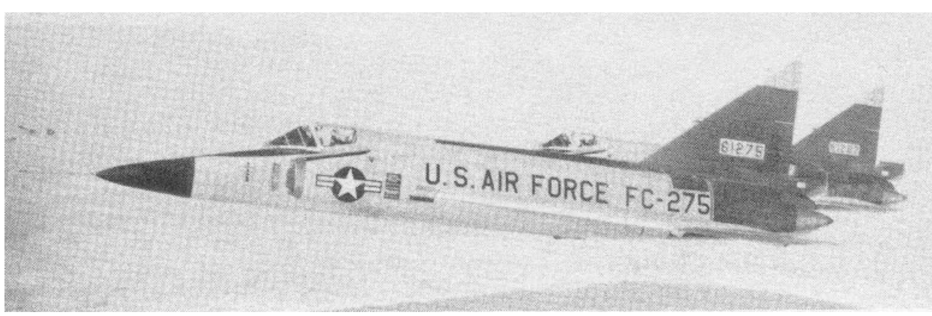


Figure 96. F-102 Delta Dagger.

The F-104 Starfighter (fig 97) is the most widely used fighter-interceptor in the free world air forces. Production for USAF has been completed, but variations of the F-104 are being built under the Military Assistance Program in Canada, Germany, Belgium, The Netherlands, Italy, and Japan. Greece and Turkey air forces also will use the F-104. The Starfighter version employed in the U.S. has a speed of more than 1, 400 miles per hour, a range of approximately 600 miles, and a ceiling above 55, 000 feet. The F-104 is armed with Sidewinder missiles and Vulcan 20-mm cannons.

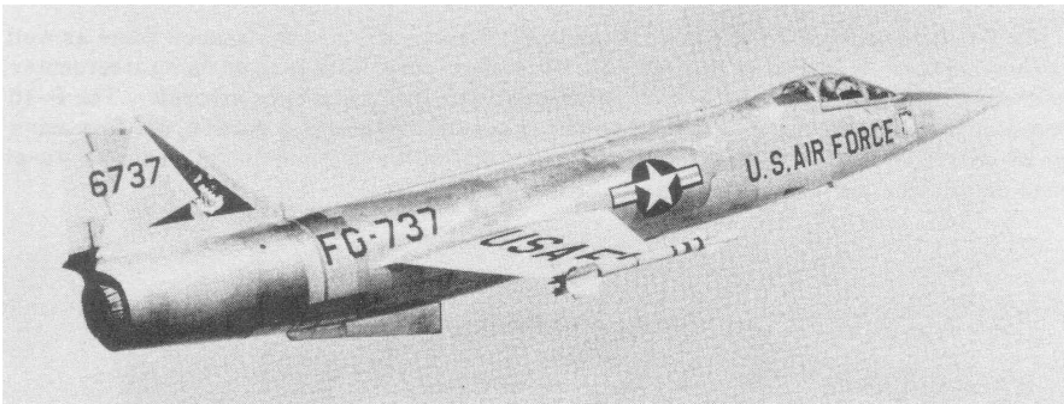


Figure 97. F-104 Starfighter.

The F-106A Delta Dart (fig 98), evolved from the F-102 Delta Dagger and has a more powerful engine; a redesigned tail, fuselage, and fuel tank; and improved electronics and armament. The aircraft's electronic guidance and fire control system has the capability of flying the aircraft soon after takeoff through a cruise position to an attack position, detecting targets, firing at optimum range, and immediately breaking off to seek other targets. At one time, the F-106A held the world speed record at 1, 525.9 miles per hour. Its range is 1, 500 miles with a ceiling of 50, 000 feet. The F-106A is armed with the Genie nuclear rocket and several super-Falcon missiles. Many other jet aircraft, including the F-100, F-105, F4C, and F5A, can be used as fighters or interceptors; however, their prime mission is as fighters.

Figure 98. F-106A Delta Dart.

AIR-TO-AIR MISSILES

The primary armament of interceptor aircraft is air-to-air missiles. The Falcon family (fig 99) of air-to-air missiles are the smallest USAF guided missiles in production, having a length of approximately 6 feet, a diameter of about 6 inches, and a weight of about 100 pounds. Five basic versions of the Falcon have been produced. Some use radar-homing guidance; others use infrared homing. All have solid-propellant rocket motors. One later model has a nuclear warhead. All of the missiles have supersonic velocity (mach 2, plus the speed of the aircraft), a ceiling above 50, 000 feet, and a range greater than 5 miles.

AIM-26 (formerly GAR-11), an advanced version of the Falcon family, combines the nuclear capability of Genie with AIM-4A accuracy. Carrying a small-yield nuclear warhead, its semiactive radar guidance system enables low-altitude intercept. AIM-26 can be used on all F-102 aircraft.

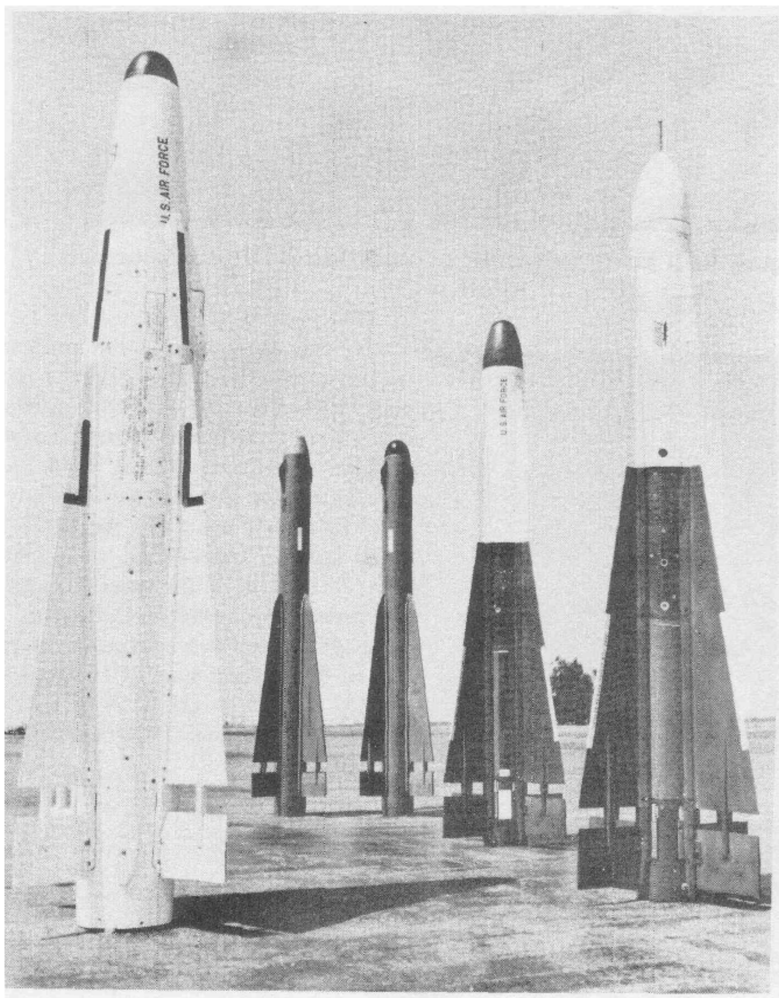


Figure 99. Falcon family of missiles (left to right): nuclear-capable AIM-26A, infrared AIM-4, radar homing AIM-4A, infrared AIM-4F, and radar homing AIM-4E .

Genie (AIR-2A) (fig 100) is an air-to-air rocket that carries a nuclear warhead. It is unguided and uses a solid-propellant rocket motor. Genie is carried under the wing of the F-89J interceptor and in the missile bays of the F-101 and F-106. The missile has a length of 10 feet, a diameter of 17 inches, and a weight of approximately 800 pounds. The missile reaches supersonic velocity (mach 3, plus the speed of the aircraft) and can destroy targets at altitudes above 50, 000 feet and at ranges of about 10 miles.

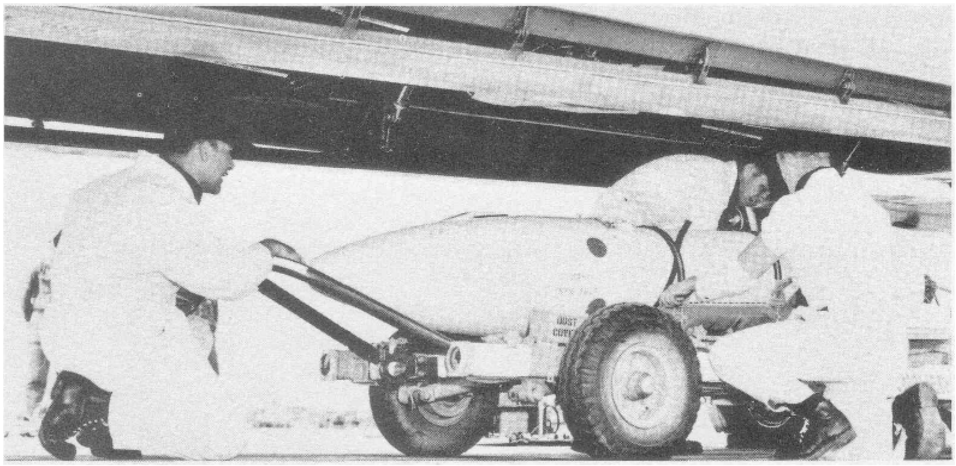


Figure 100. Genie rocket being loaded on the F-106A Delta Dart.

SURFACE-TO-AIR MISSILES

Bomarc is a missile that resembles an aircraft in configuration (fig 101) and uses a solid rocket booster and two supersonic ramjet engines to develop speeds in excess of mach 2 and reach altitudes above 70, 000 feet. It is guided from the ground to the vicinity of the target by commands from the SAGE system. As the missile approaches the target, a homing guidance system on the missile takes control and steers the missile to intercept. The nuclear warhead is detonated by a proximity fuze. Bomarc has a wing span of 18 feet, a length of about 57 feet, a height of 10 feet, a weight of about 15, 000 pounds, and a range in excess of 400 nautical miles.

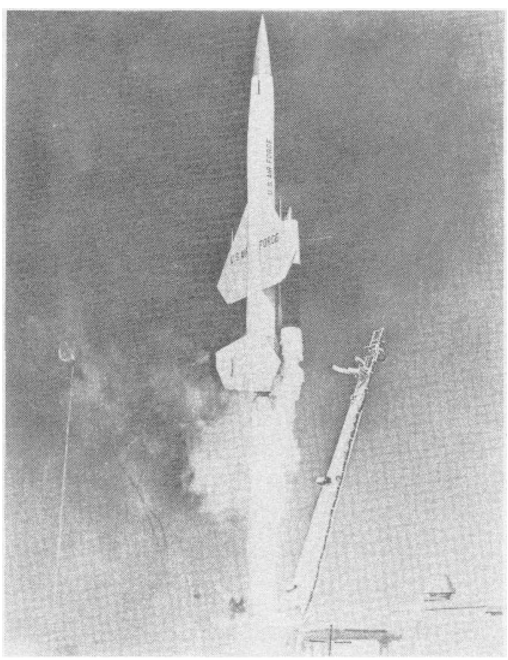


Figure 101. Bomarc missile at instant of firing.